Safety and Design Innovation in EMS
The Cutting Edge and You!

Who am I?

- Nadine Levick MD, MPH
- Emergency Medicine Physician and Public Health Academic, (USA-Hopkins, Harlem, Maimonides, Brookdale & Australia – Royal Melbourne, Royal Children’s Hospitals, Royal Australian Flying Doctor Service)
- Chair, National Academies Subcommittee TRB EMS Transport Safety, USA
- Founder of EMS Safety Foundation
- Recipient, International Society of Automotive Engineers, Women’s Leadership Award for EMS Safety

Dubai Ambulance Corporation is leading in seeking out and applying technically sound innovation on ambulance systems safety

So where am I from….

Much of what you shall hear today is thanks to the work of all of those in the:

- EMS Safety Foundation Leadership Award presented to Khalifa AlDarri - March 21, 2017

And.. what is innovation?

- Something new, original and more effective

Dubai Ambulance Corporation is leading in seeking out and applying technically sound innovation on ambulance systems safety

So what is safety?

- Condition of being protected against undergoing or causing harm, injury or loss
**Very Important Principle**

Ambulance transport safety is part of a SYSTEM, the overall balance of risk involves the safety of all occupants and the public.

---

**So what are we going to cover today??**

- What we know now, and need to do
- What is there for the forward thinkers
- The future horizons

---

**So**

- What's important
- What's not important

---

**Core aspects**

- Ambulance transport safety "is part of a system"
- Patient safety... and provider and public safety too!
- New developments and safety initiatives
- Need for measurement for safer performance
- Creating a 'culture of safety' thru awareness, training, design, technology and incentive.

---

**Testing the real world**

- What is new
- What is not new
- What's going to save your life
- What might take your life
- What's going to hurt you
- What's going to protect you
- What is factual
- What is garbage

---
Innovation
Collaboration
Knowledge transfer

Goals
- Standards for safety
- Policy based on Science
- Databases to demonstrate outcome

EMS Safety timeline
- Didn’t know it was an issue – 60’s-70’s
- Knew it was an issue – but didn’t really know what to do – 80’s-90’s
- Safety technical data rolls out – past 10 years
- Change and adoption challenges – we are here now

Leading Change
Implementing & scaling for change
- Make it stick
- Build on the change
- Create quick wins
- Empower action
- Communicate the vision
- Create a plan for change
- Create a powerful coalition

Gartners Hype cycle 2013

Gartners Hype cycle 2016

EMS Safety’s frontier -
- the interface of disruptive new tech and operational practice at all levels of the EMS system and across disciplines

You’re about to hear about
- Voice activated commands
- Drones
- Vertical take off vehicles
- Fleet mix
- Virtual reality
- Smart phone technology
- Wireless patient monitoring
- Connected health
- Health Information Exchange (HIE) Applications
Things can go wrong – but when there are sound safety policies and technologies in place, and the system is well prepared, you can minimize harm.

And yes, this meets KKK or NFPA

EMS work environment!!

<25 mph - A survivable impact??

Occupant protection......??

Safety in this vehicle...?

Single vehicle crash rear compartment fatality
So…
- Which vehicle do you want to be in?
- Which vehicle is the best for efficient, and effective patient care?
- Which vehicle provides optimal risk management?
- What is the optimal fleet mix?

Ambulance Sparing
- In almost ¼ (23.5%) of all motorcycle missions ambulance use was avoided!

Safety is a tool to save
- Lives
- Time
- Money
- must be evidenced based

Safety Dimensions
- Safe systems – CRM / transport system safety
- Risk perception
- Fleet and operations management
- Vehicle design safety
- Scene safety
- Patient Handling
- Health and wellness

Some new aspects
- Vehicles – smarter, sleeker, safer – CHEAPER!
- Operations – new technology tools
- Interdisciplinary infrastructure – new global platforms
Safety in EMS is INTERDISCIPLINARY
clinical practice
public health
automotive safety
impact biomechanics
human factors
fleet safety

USA ambulance vehicles have also not fundamentally changed in operational design in 30 years

- Despite a global environment in the transportation arena of major advancements in technology, engineering, automotive safety and human factors over that time.

1980’s Then….

And NOW!…

USA 1980’s Then….

And 2017…

Safety challenges to address

- High per vehicle and per mile travelled fatality rates
- Vehicles essentially designed outside of the automotive safety and occupant protection arena
- Exempt from federal commercial fleet safety oversight (FMCSA) and most FMVSS
- Driven by drivers overrepresented in high risk group: under 25 years of age/male
- Dangerous driving practice: Travel at high speed and run red lights

Yet….

- In less than 3% of transports is it a life threatening emergency

the EMS transport process

- communications/dispatch
- the patient
- restraining device/seat
- transporting device/gurney
- paramedic/transport nurses, doctors & family
- patient monitoring equipment
- clinical care & interventions
- protective equipment
- the vehicle
- the driver/driving skill
- other road users
- the road

The Emergency Department (ED)

An ambulance is not an ED /ICU on wheels
Firstly!

- An accident?
- or
- a predictable and preventable event

USA EMS transport safety data estimates
includes police report data and estimates based on known data capture deficiencies
- ~ 81,000 vehicles
- upto 9,000 crashes a year
- ~ One fatality each week
  - ~ 23 pedestrians or occupants of other car
- ~ 10 serious injuries each day
  - >50% not ambulance occupants
- Cost estimates > $500 million annually

In the absence of a data capture system for EMS safety performance, Government estimates can underestimate the situation.

Of course medics are not wearing their seat belts...

Challenging design related Human Factors

Equipment hard to reach

Interior design exposes EMS to unnecessary automotive and ergonomic hazards

‘Workplace’ Hazards
In the USA there are more safety standards for moving cattle than for moving patients.

This vehicle is safety crash tested by automotive experts.

Unlike this vehicle.

**USA Absence of safety performance standards and oversight**

- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No system safety performance standards
- Absent national safety oversight

**In the USA industry is trying to respond to this safety crisis and doing crash testing – but to what standard?**

KJK, NFPA do not address crash testing.

**Ambulance Design and Standards today**

- KJK
- NFPA
- SAE
- ASTM 1517
- NASEMSO MVDR
- GVS
- CAMTS
- FMVSS – largely exempt
- FMCSA - exempt
- State required ambulance equipment
- International: CEN 1789, ASA 4535, Indian St

**Vision Zero**

A conscious decision to eliminate death and serious injuries.

**Safe Systems Approach**

- Leadership
- Setting up targets
- Knowledge
- Community Engagement
Safe Systems Approach

Systems safety of:
- Dispatching a vehicle
- Getting you, your patient and equipment to, in and out of the vehicle
- Providing patient care inside the vehicle
- Occupant protection in crash and near miss situations
- Public safety

Safe Systems Approach

System Design Constraints
- Do the clinical work that is required and essential
- Not get hurt or killed
- Not hurt or kill anyone else
  So...
- Clinical need
- Human tolerance of injury

When is it safe to do what...?
- What are your policies???
  - If your patient is pink, warm and talking?
  - Are you required to notify the driver if you are out of your seat belt?
  - Are ‘routine procedures’ putting you at risk?

A System of Safety
- And there are some cutting edge examples of safety innovation right outside that door

The top three safety and design advances
- Invehicle Fleet telematics and warning systems
- OEM vehicles with ESC and crashworthiness and forward and rear facing seating only AND
- Laterally moving stretcher platforms
Ambulance Transport Safety is complex AND multidisciplinary.

- Epidemiological data collection
- Biomechanical automotive safety
- Personal protective equipment
- Driver training
- Communications technology
- Safety technology
- Regulations and standards
- Fleet safety program

Key elements to transport safety:
- Impact Biomechanics
- Transport Ergonomics
- Fleet Safety

The Laws of Physics Prevail...

Engineering research is different

What is a safe speed and how do we identify that?

What is a survivable impact?

E = \frac{1}{2} mv^2

v^2 = 2a

~ 30 mph - survivable

12 mph (20 km/hr)?
What is a survivable impact?

\[ E = \frac{1}{2}mv^2 \quad v^2 = 2as \]

~ 60 mph – not survivable

A survivable impact??

Vehicle Crashworthiness testing

- USA – research & marketing
- Europe – 2017 to meet CEN

So ambulance design technical science… Not really a new issue

Letter to Abe Lincoln – 1864 re: safety of ambulance design

1864 Ambulance Design Patent and diagrams
Almost 150 years ago

Where is the science today?

Ambulance Safety Research: No longer such a New Field

<table>
<thead>
<tr>
<th>Year</th>
<th>Accident Rate</th>
<th>Safe</th>
<th>Safer</th>
<th>Non-Safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Published research in automotive safety engineering

We should use the best safety practices demonstrated in engineering and in ergonomics.

The results of the frequency analysis, green dots mark equipment used every time the ambulance is driven, orange every day, red every week and so on.

And this all takes place in 60 milliseconds—the blink of an eye.

A harness is NOT a solution; it will just break your neck at speeds that you would otherwise not have an injury.
PPE from the stationary environment can be highly hazardous in the automotive setting.

NOT new technical data...

Beware some provider restraint systems are dangerous.


Side facing 4-point harnesses demonstrated to be lethal, even at slow ground vehicle speeds.


Side facing 4-point harnesses demonstrated to be lethal, even at slow ground vehicle speeds.

Being seated IN an automotive seat is what will protect you

- Anything that allows or encourages you to get up out of your seat will also encourage you to be injured or killed – it is potentially lethal to be out of your seat in any fashion
- 4 or 5 point harnesses over both shoulders for sidefacing occupants are potentially lethal – and in NO WAY SUPPORTED BY ANY DATA OR INDEPENDENT AUTOMOTIVE SAFETY EXPERTISE

Dynamic Sled Testing of Ambulance Pediatric Restraints

Deceleration Sled test (upon impact) 24 G, 30mph


If we know this – and its published....

Suboptimal design and practices result in bad outcomes for health care delivery and EMS service safety

Safety is Good Business
The solution

- Optimized design of ambulances so you can reach your patient and equipment without getting out of your seat
  - Forward and rear facing seating
  - A laterally sliding stretcher platform
  - Equipment stored on the curbside wall
Clever knowledge transfer, a game changer from Dlouhy in Europe

The old expensive and not versatile and the new... Rapidly and game changing technology and cheaper, better, very versatile

Ambulance Safety Innovation Design Module 1.0
www.INDEMO.info the future concepts you can have right now!!!
Better, safer and cheaper
Self Guided INDEMO tour

http://www.emssafetyfoundation.org/video/INDEMOredstrobe.mp4

Interactive Scale Models
An iPad on mini segway 'legs' which can be self driven from a cloud based platform from anywhere globally was utilized to share the INDEMO design features beyond its physical location.

Telepresence Robot

- An iPad on mini segway 'legs' which can be self driven from a cloud based platform from anywhere globally was utilized to share the INDEMO design features beyond its physical location.

INDEMO had a tour!

You can too!

http://www.emssafetyfoundation.org/INDEMOScheduleForm.htm

Schedule an onsite and/or telepresence session with

INDEMO and Andi

http://www.emssafetyfoundation.org/INDEMOScheduleForm.htm
INDEMO in the classroom

Dissemination

- Public access web site - [www.INDEMO.info](http://www.emssafetyfoundation.org/INDEMO/ScheduleForm.htm)
- Workshop and classroom seminars
- Concept of copy left
- Active encouragement of dissemination of safety focused design via social media
- Use of this interactive hands-on model and virtual access to engage the EMS community in the USA and beyond.

Impact

- Beyond our research team, the INDEMO project has featured in numerous presentations by leaders in EMS as a cutting edge gold-standard
- Also on twitter, Instagram and periscope by end users, with numerous requests by end users and corporate industry organizations for design information
- Even a ‘clone’ at 2016 Rettmobil

Rettmobil 2016 – an INDEMO ‘clone’

Soterawireless & Intel’s Eric Dishman

http://www.visimobile.com/visi-product-info/

Wearable tech..
93 per cent of Jawbone users in cities < 24 kms from epicentre woke up suddenly at 3:20 a.m
jawbone.com/blog/napa-earli...
pic.twitter.com/2pI0rG7XRM7 @tlucartes
Telematicus
Fleet Management capability
Vehicle database
• Individual vehicle data
• Fleet mileage collection/tracklist
• Link to other systems (SAP, Fleet)
Maintenance & Service Plans
• Repair history & scheduling
• Action planning
Reporting
• Export to Excel for manipulation
• Scorecard views, Crystal Reports
Object Feedback

Extensive Indirect cost savings
• Fewer out of service vehicles
• Improved transport times
• Decreased administrative lost in managing unsafe behaviors
• Decreased legal burden
• Automatic system wide data
• Insurance benefits

The ambulance response vehicle of the future?

And even now AED Drones!

? The ambulance of the future
First passenger drone makes its debut at CES

eHang passenger drone

Urban Aeronautics – vertical take off drone

LITMOTORS

 eHang passenger drone

LITMOTORS

 eHang passenger drone

Urban Aeronautics – vertical take off drone

And even now AED Drones!

The ambulance response vehicle of the future?
Very Important Principle

Ambulance transport safety is part of a SYSTEM, the overall balance of risk involves the safety of all occupants and the public.

What do we know works…

- Tiered dispatch
- Vehicle Operations Safety Policies
- Forward and rear facing seating
- Laterally sliding stretcher
- Securing equipment
- Validate/Integrate disruptive technologies
- Fleet management electronic technical devices
- Safety awareness
- Cultural change

Technical Collaboration is key

- We are NOT the experts in this science
- We cannot afford to play the silo game here, it is costing lives, time and money
- We MUST have a meaningful evidenced based approach to design, operations and policy
- We must be outcomes driven

Conclusion

1) Safety must be inherent to operational process design
2) Engagement of appropriate interdisciplinary expertise in systems design, transport safety human factors and safety analysis is essential
3) An understanding of the complex interplay between patient, provider and public safety from a systems perspective and culture is key to addressing effective and safe operational EMS performance.

Thank you!

Any Questions??
Electronic handout and resources available online
http://www.objectivesafety.net
How to study healthcare work

Distinguish and discover how healthcare work...

1. Should work
2. Could work
3. Can work
4. Could work
5. All approaches need to work together

Safety Event reporting

1. All EMS vehicle operators
2. All patients
3. All non-EMS passengers (cab and patient compartment)
4. All EMS practitioners (when patient care allows)
5. All infants and toddlers (these children should be transported in an age appropriate child seat if their condition allows). Children should not be placed in cab passenger seat with airbag.

Seat Belt and Restraint Use:

Seat belts or restraints will be securely fastened to the following individuals when the vehicle is in motion:

1. All EMS vehicle operators
2. All patients
3. All non-EMS passengers (cab and patient compartment)
4. All EMS practitioners (when patient care allows)
5. All infants and toddlers (these children should be transported in an age appropriate child seat if their condition allows). Children should not be placed in cab passenger seat with airbag.

e. Avoid Distracted EMSVOs

1) Distracted driving is responsible for many MVCs, and EMS agencies should assure that policies reduce the risk of a distracted driving accident.

a) EMSVOs should not view pagers, cell phone screens, text messages, or mobile data terminals or enter data into GPS devices while an EMS vehicle is in motion.

Summary

- New Resources
- New Data
- New Relationships

Social Media Explained

- 6 word abstract
  - Social good
  - Community engagement
  - Crowdsourcing
  - Open/augmented government data
  - Public Health & Safety
  - Saving lives

- I'm thinking about finding AEDs
- I am finding AEDs
- This is where I am finding AEDs
- Why am I finding AEDs
- Still shot of me finding AEDs
- Live action shot of me finding AEDs
- God, I am good at finding AEDs
- Everyone...let's find AEDs together